ARKIV FÖR FYSIK Band 17 nr 9

Communicated 2 December 1959 by Kai Siegbahn

Experiments with a low inductance high vacuum X-ray flash tube set

By Per Ohlin and Sture Händel

With 6 figures in the text

ABSTRACT

A new type of low inductance X-ray flash tube is described. A low inductance condenser has been used and the intensity of the X-rays has been studied for some different circuit inductances. A new phenomenon has been observed; the intensity was shown to depend strongly on the circuit inductance.

Introduction

Although it is known that considerable work on improvements of high vacuum X-ray flash tubes has been carried out at several laboratories very little has been done to reduce the circuit inductance. To get a higher intensity and penetration

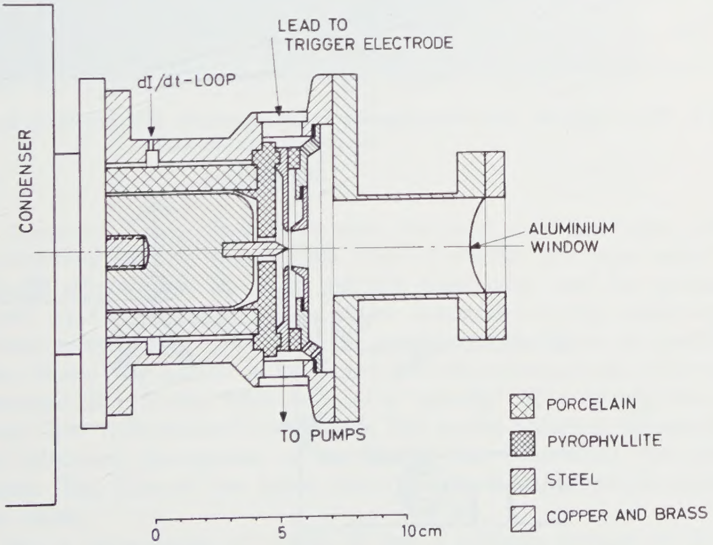

Fig. 1. Drawing to show the connection of the X-ray flash tube to the high voltage condenser.

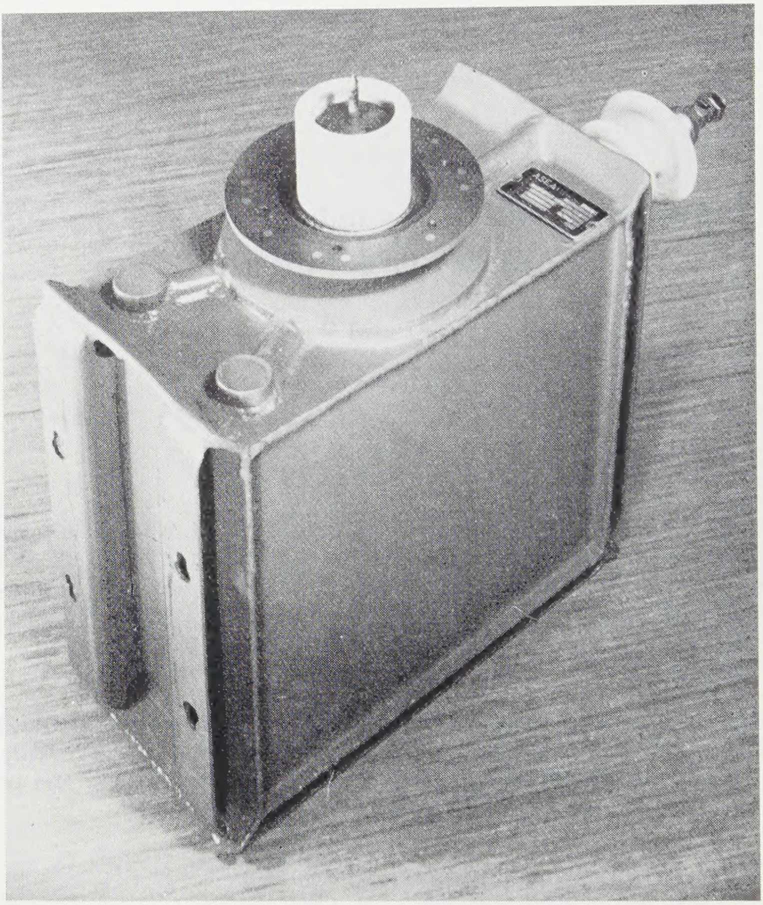

Fig. 2. The condenser with the tungsten anode mounted. The porcelain insulator to the right is the connection for H.T.

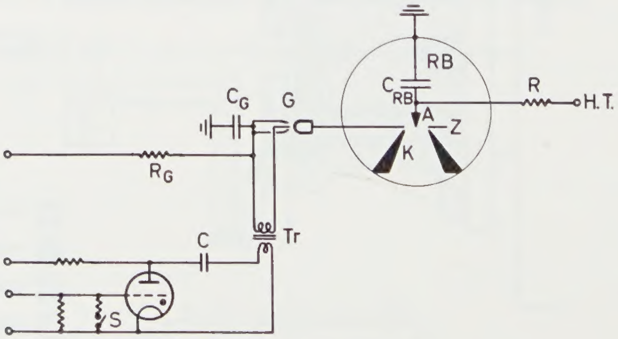

Fig. 3. The circuit diagram of the X-ray flash tube set.

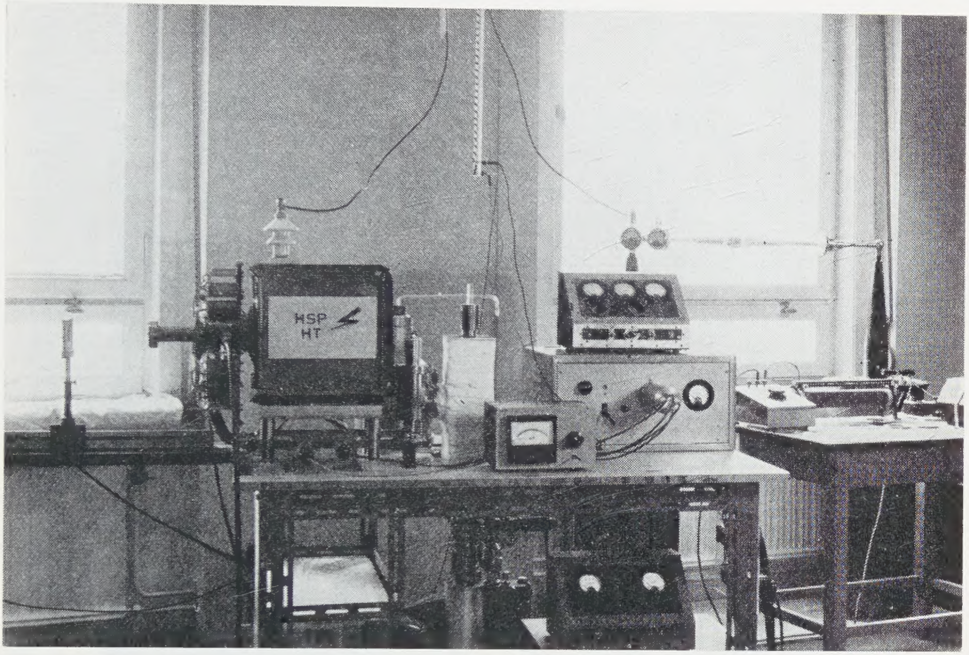

Fig. 4. Total view of the experimental arrangement.

power the voltage has been increased to very high values. Since the inductance has the effect of lowering the effective voltage we have built up an apparatus with low inductance. In addition a new interesting effect has been observed, however, and although we have found it quite recently and the experimental material is fairly scanty so far, we believe that the new phenomenon is of such significance that we would like to report on it on this stage of the experiments.

Apparatus

In commercial types of X-ray flash tube sets the tube and the high voltage condenser are constructed as two units. This type of set has not been used. The tube has been placed directly on the high voltage condenser, and the porcelain insulator is soldered on the condenser. The entire connection to the condenser is shown in a cut-away view in fig. 1. As seen, the porcelain tube forms an insulator in a coaxial cable, where the anode is the inner and the envelope the outer conductor. In this manner the X-ray flash tube is a coaxial cable during the discharges, and a very low inductance is obtained. The anode holder is threaded on the condenser and different dimensions of the holder has been used. The anode is made of tungsten. The X-rays are taken out through the aluminium window, which is 0.05 mm thick.

The condenser has a capacitance of 0.402 μF and a working voltage of 50 kV. Fig. 2 shows the condenser. The inductance of the system is about 50 mμH.

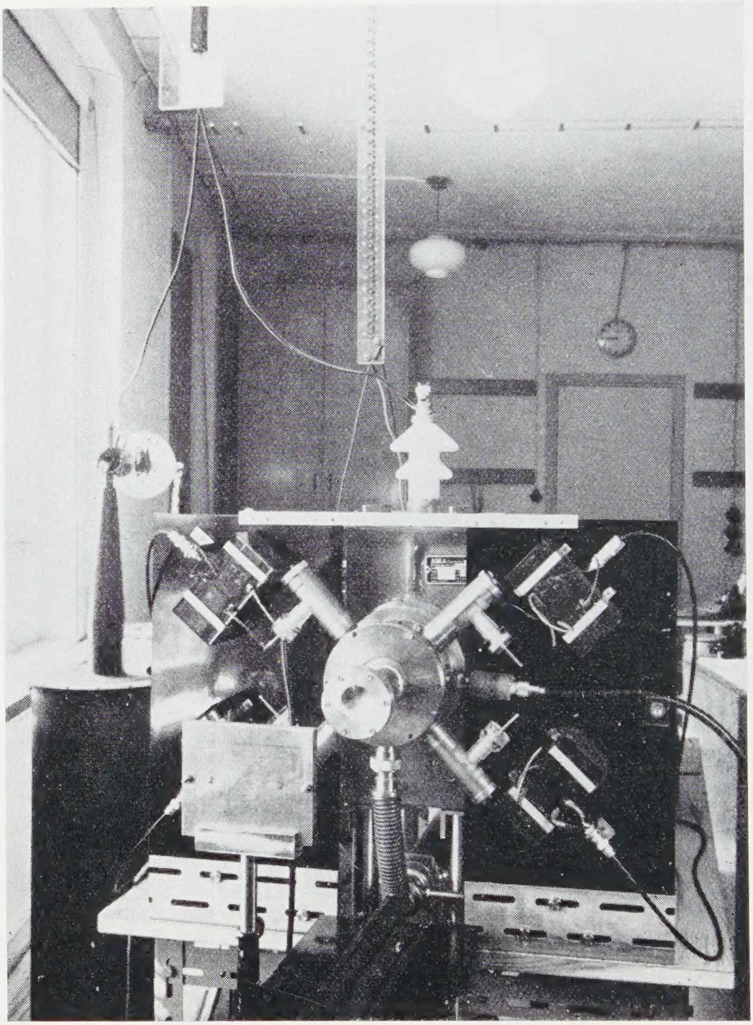

Fig. 5. Front view showing the tube and the spark gap units. To the right the cable for measuring dI/dt.

To fire the tube a spark gap unit is used (cf. fig. 3). A pulse of high voltage from the pulse transformer Tr produces a spark in G and the condenser C_G is discharged over the trigger electrode to the cathode. This causes the X-ray flash tube to break down. The spark gap unit is coaxially mounted on the tube; the envelope is the outer conductor.

The discharges have been studied by oscillographic recordings of the time derivative, dI/dt, of the current through the tube. dI/dt is measured by means of a small loop.

Total views of the experimental arrangement are shown in figs. 4 and 5.

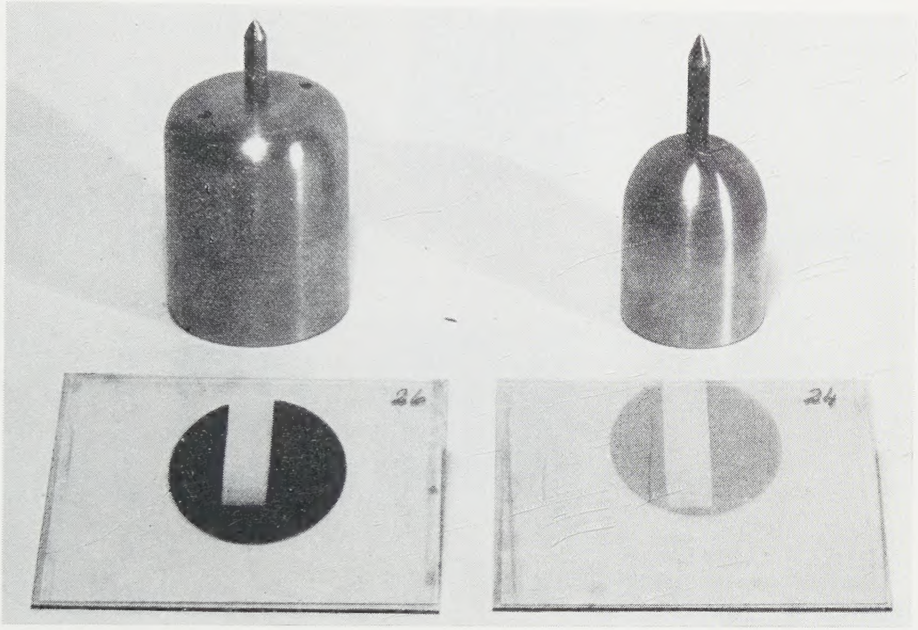

Fig. 6. Plates showing how the intensity varies with the anode dimensions. Recorded at 50 kV and only *one* discharge. On plate 26 the steps can be discerned.

Results

The intensity of the X-ray flash tube has been recorded photographically. In front of the plate an aluminium step filter is mounted and an investigation of the intensity and penetration power has been made. In the experiment we have used different dimensions of the anode holder and in this manner the circuit inductance has been changed. A maximum diameter of the holder has been found to give the highest intensity and penetration power. In fig. 6 two anode holders are shown with the corresponding plates. They have different diameters and heights. The heights of anode and holder together are the same. The smaller holder increases the circuit inductance about 20 % and gives a considerable weakening of the intensity, as is seen.

The experiments are going on and detailed investigations of the above mentioned facts are planned.

Institute of Physics, Uppsala.

Tryckt den 15 mars 1960

Uppsala 1960. Almqvist & Wiksells Boktryckeri AB